

TECHNICAL REPORT

RESULTS OF LABORATORY TESTS OF WATERPROOFING AND SEALING PRODUCTS MANUFACTURED BY E.WOOD LTD, GREAT BRITAIN, FOR WATERPROOFING AND SEALING APPLICATIONS WITHIN TUNNELS, AND OTHER UNDERGROUND AND OVERGROUND STRUCTURES OF MOSCOW UNDERGROUND

MOSCOW - JULY, 1995

The tests have been carried out in accordance with the Program of laboratory tests for evaluation of waterproofing and sealing products of E.WOOD LTD and determination of the products suitability for potential applications within Underground tunnels and other building constructions operating under permanent and adverse hydro-geological conditions, approved by AD REM Company - an official distributor of E.WOOD LTD within CIS and the Baltic States, in April, 1993.

THE TESTED PRODUCTS

Waterproofing products: WALL-TECH CWC
WALL-TECH RG

Sealing products: SEAL-TECH CC in combination with
FLEXI-TECH PRIMER

The tests were conducted by The Laboratory of Waterproofing Products at CNIIS in May - July, 1995.

The purpose of the tests included the determination of general physical, mechanical, and technological properties of the tested products in accordance with the requirements of:

GOST 310.4-81 - "Cements. Methods of determination of strength limits under compression and bending."

GOST 101.80-90- "Concretes. Methods of determination of the strength under compression and bending";

GOST 12730.5-84 - "Concrete. Methods of determination of waterproofing properties";

GOST 25621-83 - "Sealing and insulating polymer building materials and products. Classification and technical requirements";

Methodical Recommendations, compiled by CNIIS.

I. Determination of physical, mechanical, and technological properties of the waterproofing products

WALL-TECH CWC

WALL-TECH RG

I.I. Determination of physical, mechanical, and technological properties of the waterproofing product

WALL-TECH CWC

I.I.I. General physical-mechanical properties of WALL-TECH CWC are given in Table 1.

Table 1

No.	Test	Unit	Test Results after			Notes
			3 days	7 days	28 days	
1.	Adhesion of concrete at detachment	MPa	0.26 (2.57)	1.3 (12.7)	1.8 (18.2)	CNIIS Meth. (plates)
2.	Compression strength	MPa	9.1 (91)	33.4 (334)	51.3 (513)	CNIIS Meth. (cubes)
3.	Shrinkage after curing	%	0.02	0.06	0.07	Not all cubes shrunk.

NOTE: Figures in brackets are kg/sq.cm.

Tests on WALL-TECH CWC adhesion to concrete surface at detachment and compression strength showed their increase at increasing cure period in wet environment.

I.1.2. Test results for the samples of draining models with applied WALL-TECH CWC are given in Table 2.

Table 2

No.	Test	Unit	Test Results after:					Notes
			7 d.	10 d.	14 d.	21 d.	28 d.	
1.	Hydro-pressure under which appeared dark spots(mist up)without condensation	MPa	0.25 (2.5)	0.35 (3.5)	0.45 (4.5)	0.74 (7.4)	0.95 (9.5)	After 21 d. dark spots were no more observed.

NOTE: The figures in brackets are kg/sq.cm.

The Table 2 shows one of the best results. It follows, that the waterproofing properties of the product considerably increase with time of exposure.

Note: the waterproofing properties of WALL-TECH CWC in accordance with GOST 12.730.5-84 for concretes testing correspond to type W10.

1.1.3. The test results for the samples in the form of concrete models with applied WALL-TECH CWC under the exposure to direct pressures through holes of 5 mm in diameter are given in Table 3.

Table 3

No	Test	Unit	Test results after				
			7days	10days	14days	21days	28days
1.	Hydro-pressure at which appeared dark spots (mist up) on the product applied by 3 mm coat onto the model under direct exposure to water coming through the bored holes of 5 mm diameter.	MPa	0.05 (0.5)	0.05 (0.5)	0.1 (1.0)	0.11 (1.1)	0.11 (1.1)

NOTES: The figures in brackets are kg/sq.cm.

Dark spots (mist) on the product surface were observed only at the locations of holes.

It follows from Table 3 that WALL-TECH CWC applied in 2 coats with total thickness of 3 mm is capable of resisting direct water pressure of over 0.1 MPa during 0.5 hours without mist up spots appearing on the surface of the samples.

1.1.4. work regarding the repair of leaks through the walls of draining concrete models with dimensions of 350 x 350 x 350 mm showed that good results were obtained under the following method of application:

First, the on-going leaks were stopped by application of fast-curing WALL-TECH RG, followed by application of WALL-TECH CWC in 2 coats with total thickness of 3 mm. The product was curing at increased humidity.

Therefore, the waterproofing repair of the concrete model walls was carried out through initial application of fast-curing WALL-TECH RG to stop ongoing leakage through the holes, followed by application of WALL-TECH CWC, which was curing under highly humid conditions.

1.2. Determination of physical, mechanical, and technological properties of the waterproofing product WALL-TECH RG.

1.2.1. The general physical, mechanical properties of WALL-TECH RG are given in Table 4.

Table 4

No.	Test	Unit	Test results after			Notes
			3 days	7 days	10 days	
1.	Adhesion of concrete at detachment	MPa	0.19 (1.9)	0.34 (3.4)	0.34 (3.4)	Maximum results are obtained after 7 days exposure.
2.	Compressive strength	MPa	12.1 (121)	41.7 (417)	41.5 (415)	
3.	Shrinkage after curing	%	0.08	0.19	0.19	

NOTE: The figures in brackets are kg/sq.cm.

The tests on adhesion to concrete surface at detachment (tear) and resistance to compression showed the general increase of these properties with curing time and are highest after 7 days cure.

1.2.2. The results of the tests of WALL-TECH RG application to stop draining leaks on concrete models are given in Table 5.

Table 5

No.	Test	Unit	Test results after		Notes
			3 days	7 days	
1.	Hydro-pressure at which infiltration of water was stopped.	MPa	0.01-0.03 (0.1-0.3)	0.04-0.09 (0.4-0.9)	The figures in brackets are kg/sq.cm

Prevention of water infiltration through the walls of concrete models with dimensions 350 x 350 x 350 mm and pressure of 0.01-0.03 MPa (0.1-0.3 kg/sq.cm) can be achieved without difficulties, and is also easily achieved for the pressure of 0.04-0.05 MPa (0.4-0.5 kg/sq.cm) provided technological methods and hand tools to keep the product in place until it cures within 30-40 sec are used.

For this purpose the areas of water ingress were opened to 20-25 mm and the surface was roughened.

The application was carried out by pressing of WALL-TECH RG mixed with water at the given ratio into the leakes and holding it in place by hand tools for 30-40 sec for the product to cure.

The leakes of over 25 mm diameter were stopped by the technological methods as described above in 3 or 2 applications beginning with a larger diameter gradually reducing the size of the holes.

The elimination of leakes up to 20 mm didn't pose any serious difficulties. The elimination of leakes with water pressure up to 0.1 MPa was accomplished in 2-3 applications. The product gains full strength after 7 days cure period.

2. The determination of physical, mechanical, and technological properties of the sealing product SEAL-TECH CC in combination with FLEXI-TECH PRIMER.

The tests of SEAL-TECH CC in combination with FLEXI-TECH PRIMER have been carried out in compliance with the following standards:
 - GOST 25621-83 "Polymer building sealants and fillers. Classification and technical requirements";
 - GOST " Sealants for lining of water constructions and irrigation. Technical requirements and methods of tests", Minvodhoz USSR, 1987;
 - Methods of testing, CNIIS.

For the purpose of the tests models of cast-iron and concrete with joints of 20-25 mm width, cubes, plates, and spades were produced. The sealant was applied onto dry and wet surfaces with and without primer.

2.1. The tests results to determine physical and mechanical properties of SEAL-TECH CC are given in Table 6.

Table 6

No.	Tests	Unit	Test result	Notes
1.	Tear strength:			6 days immersion
	- without wetting	MPa	1.63 (16.3)	
	- after wetting	MPa	1.44 (14.4)	
2.	Relative elongation:			6 days immersion
	- without wetting	%	670	
	- after wetting	%	716	
3.	Residual relative elongation at tear:			6 days immersion
	- without wetting	%	33.2	
	- after wetting	%	27.8	

NOTES: The figures in brackets are kg/sq.cm.

2.2. The tests results on the technological properties of SEAL-TECH CC are given in Table 7.

Table 7

No.	Test	Unit	Test result	Notes
1.	Waterproofing of sealed joints at the given pressure: - without primer - with primer - with primer & wetting	MPa MPa MPa	0.3 (3.0) 0.3 (3.0) 0.3 (3.0)	Concrete & cast iron models
2.	Shore A Hardness	unit	40-46	
3.	Tear adhesion to concrete: - dry without primer - dry with primer - wet with primer, drying out and wetting	MPa MPa MPa	0.72 (7.15) 0.79 (7.90) 0.41 (4.1)	The surface was wetted prior to application
4.	Cure time at 20-23 deg.C	days	3-5	

NOTE: The figures in brackets are kg/sq.cm.

The sealant was applied onto both dry and wet joints, as well as with and without primer application. The tests were carried out in stages equal to 0.05 MPa (0.5 kg/sq.cm.) at 30 min. interval.

The models under the test could resist the water pressure of 0.3 MPa (3 kg/sq.cm) which meets the requirements for sealants used in construction of tunnels by open methods.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1. The waterproofing product WALL-TECH CWC provides the following physical, mechanical, and technological properties:

- Adhesion to concrete - 1.8 MPa
- Compressive Strength - 51.3 MPa

3.1.1. The waterproofing product WALL-TECH CWC can be used for waterproofing of both dry and wet surfaces within underground tunnels and other overground or underground structures without existing leaks.

3.2. Fast-curing waterproofing product WALL-TECH RG provides the following physical, mechanical, and technological properties:

Adhesion to Concrete	- 0.34 MPa
Compressive Strength	- 41.7 MPa
Admissible water pressure	0.01-0.1MPa & over
Time of elimination of leaks through the holes up to 25 mm	- 35-40 sec

3.2.1. The waterproofing product WALL-TECH RG can be used for elimination of existing leaks within underground tunnels or other underground and overground constructions.

3.3. The sealing product SEAL-TECH CC in combination with FLEXI-TECH PRIMER provides the following physical, mechanical, and technological properties:

Adhesion to Concrete surface	- 0.8 MPa
Tear Strength	- 1.63 MPa
Relative Elongation	- 716 %
Shore A Hardness	- 40-46 units
Joints Waterproofing Resistance	- 0.3 MPa
Can be applied onto both wet and dry joints.	

3.3.1. The sealant SEAL-TECH CC in combination with FLEXI-TECH PRIMER can be used as a sealant for the joints within different constructions of Underground tunnels and other overground and underground structures. Can be applied onto both wet and dry surfaces. The product is capable of curing under normal, wet, or underwater conditions.

4. CONCLUSION

Waterproofing materials WALL-TECH CWC and WALL-TECH RG, as well as the sealing material SEAL-TECH CC in combination with FLEXI-TECH PRIMER can be recommended for waterproofing and sealing repairs within Underground tunnels and other underground or overground constructions.

SIGNED:

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